Kennedy Jenks

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Technical Memorandum – Chiller Equipment Evaluation

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Subject: Santa Clara Water District Valley Water Coyote Creek Chiller
Chiller Equipment Evaluation
K/J Project Number: 1768020*06

Summary

Santa Clara Valley Water District (Valley Water) plans to construct a temporary chilled water plant to cool water from the District's Cross Valley Pipeline and discharge the cooled water into Coyote Creek, a freshwater body discharging to San Francisco Bay, during the warm-weather months of the year (March through November). The cooled water is needed to help maintain water temperatures in the Cold-Water Management Zone (CWMZ) of Coyote Creek which extends approximately 5 miles from the base of the Anderson Dam to Golf Course Drive.

Valley Water plans to install a water cooling process using mechanical chillers to cool imported water down to 16-18°C before releasing to Coyote Creek—based on historical data, imported water in Coyote Creek heats up to 24-25°C in the summer months. Coldwater management is intended to prevent downstream streamflow release to be too warm for federally threatened Oncorhynchus(O.) mykiss fish. The supply from Anderson Reservoir will be drastically reduced under Valley Water's Anderson Dam Seismic Retrofit Project which is expected to last from 2021 through 2030.

The chiller plant is to be constructed at the site of Valley Water's Coyote Pumping Plant in Morgan Hill.[1] The chiller plant will be developed as a sidestream to the Coyote Discharge Line, an existing diversion between the Santa Clara Conduit and Coyote Creek.

The primary design performance condition for the chiller plant would draw 10 cfs (4500 gpm) at 25 C (77.0ºF) inlet temperature from the Cross Valley Pipeline and produce at outflow at 16 C (60.8ºF) to Coyote Creek. The 25 C inlet condition exceeds the 99% range of observed temperatures on the Santa Clara Conduit for the period of 1989-2020. The water cooling process would be designed to meet the criteria stated with unit redundancy.

[1] The Santa Clara Conduit and Cross Valley Pipeline are part of a common transmission system. The Santa Clara Conduit is the intake pipeline to the Coyote Pumping Plant. The Cross Valley Pipeline is the discharge pipeline from the Coyote Pumping Plant.

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As stated above, the primary design performance conditions exceeds the 99% range of observed temperatures. If the 'standby' chiller is called into operation, the plant would have the capacity to produce a 13.5ºC (24.3ºF) temperature reduction for the design 10 cfs. This would allow for:

- An inlet temperature of 29.5ºC (85.1ºF) to be reduced to the design outflow temperature of 16ºC (60.8ºF). This would exceed the 99.5% range of observed temperatures.

- The maximum observed inlet temperature of 30.3ºC (86.5ºF) would produce an outlet temperature of 16.8ºC (62.2ºF). Valley Water has set the criteria for the maximum allowable outflow to Coyote Creek at 18ºC (64.4ºF).

Kennedy Jenks evaluated four chiller equipment alternatives; 1) water cooled, 2) air cooled, 3) cooling towers and 4) evaporating cooling using cooling towers followed by water cooled (a two-stage process). The water cooled and combined cooling tower/water cooled options appear to be the best selections based on capital and operating costs, and noise considerations. Kennedy Jenks recommends that Valley Water consider both alternatives with understanding that the two-stage water-cooling process would reduce capital and operating costs with additional environmental operations risks.

The water cooled approach would consist of a refrigerant chiller plant with overall capacity of 4,500 tons, utilizing a 2+1 chiller plant design (three 1,500-ton chillers). The estimated cost for the chillers and accessories is $4,000,000.

In the two stage approach, the first stage would consist of a parallel system of cooling towers that would reduce the water temperature to approach the ambient wet-bulb temperature conditions. The second stage process would consist of a refrigerant chiller plant with overall capacity of 1,800 tons utilizing a 2+1 chiller plant design (three 600-ton chillers). Two units would provide sufficient cooling for >99.5% of inlet water conditions from the Santa Clara Conduit/Cross Valley Pipeline transmission system. The larger capacity of the standby unit would increase the overall plant capacity for operation under high inlet water temperature conditions. The estimated cost for the cooling process equipment and accessories is $3,500,000.

The water cooling process would incorporate a low-flow, by-pass, separate from the Coyote Discharge Line, allowing water to be diverted from the Cross Valley Pipeline to Coyote Creek without passing through either or both stages of the cooling equipment depending on ambient air and inlet water temperature conditions.

The chiller units would incorporate variable-speed control to better regulate unit operation with changes in inlet temperature conditions. The chiller units would incorporate the Turbocor™ shaft design, incorporating a magnetic bearing system. The Turbocor™ design reduces maintenance and operates with less noise compared to the traditional oil-lubricated chiller design.

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The chiller plant would incorporate a water-cooled heat rejection system, closed-loop water recirculation systems, and heat exchangers to isolate the raw water streams from the Cross Valley Pipeline from potential contamination of the chiller equipment.

The chiller plant would include an instrumentation and control system to control chiller plant output and monitor chiller equipment operation. The instrumentation and control system would be cloud-based, allowing for remote control and monitoring by Valley Water personnel.

All chiller plant equipment would be housed in skid-mounted, sound-attenuated enclosures to limit the sound level outside of the equipment to 73 decibels at a distance of 3 feet outside of the enclosure.

A 3-hour workshop was held on February 12, 2021 with Valley Water staff representing management, operations, fisheries, civil, mechanical, electrical and controls to discuss the four alternative chiller equipment alternatives and select the equipment type to be used for this project. The workshop evaluation considered 11 evaluation criteria on a weighted basis and the group selected the water cooled equipment option. The final ratings for the four alternatives were as follows:

1. Water Cooled – 253 total points
2. Cooling Towers/followed by Water Cooled – 227 total points
3. Air Cooled – 186 total points
4. Cooling Towers – 172 total points

Additional information on the equipment selection workshop is located in Conclusions and Recommendations portion of this technical memorandum.

Project Background

Anderson Dam and Reservoir are located three miles east of U.S. 101 in Morgan Hill; the Reservoir is Santa Clara County's (County) largest surface water reservoir. The reservoir supplies water for treatment and distribution to wholesale customers of the Santa Clara Valley Water District (Valley Water). Water is also released from the reservoir into Coyote Creek, a freshwater body discharging to San Francisco Bay.

Valley Water's Anderson Dam Seismic Retrofit Project (ADSRP) and Anderson Dam Tunnel Project (ADTP) are being carried out to improve the reliability and safety of the dam and to allow a return of the Reservoir to its original design operating level and storage capacity.

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During the anticipated 10-year construction period of the ADSRP, water released from Anderson Reservoir to Coyote Creek would be cut drastically. To replace the lost supply to Coyote Creek, water is to be diverted from the Cross Valley Pipeline and discharged to Coyote Creek. The Pacheco-Santa Clara Conduit transmission system transports water from San Luis Reservoir, located in the San Joaquin Valley, into Valley Water's service area for treatment and distribution to wholesale customers. Figure 1 provides a map of the Pacheco-Santa Clara Conduit transmission system, the Coyote Pumping Plant, Anderson Reservoir, and Coyote Creek. Figure 2 shows a map of the Coyote Pumping Plant, the Santa Clara Conduit into the plant, the Cross Valley leaving the plant, the Coyote Discharge Line diversion to Coyote Creek, and the Anderson Force Main to Anderson Reservoir.

During Summer and periods where the temperature of the water in the transmission system exceeds 18ºC (66ºF), the water diverted from the Santa Clara Conduit is to be routed through a temporary chilled water plant described within this report. The chilled water plant would be plumbed as a sidestream from the Coyote Discharge Line, an existing branch diversion from the Coyote Pumping Plant (CPP) that is routed to Coyote Creek. The Coyote Discharge Line is occasionally used outside of the Summer season.

The chilled water plant is to be constructed for coldwater management within Coyote Creek during the Summer season. With the proper manipulation of valves at the CPP, the Coyote Discharge Line can continue to be used to divert flow to Coyote Creek when off-season, chilled water plant operation is not required. Coldwater management is intended to prevent downstream streamflow releases that are too warm for native aquatic species, including the federally threatened Oncorhynchus(O.) mykiss fish.

Chiller Plant Design

The primary design parameters listed below have been set for the performance of the chilled water plant. The chilled water plant is to be designed incorporating multiple chillers, with (N+1) unit redundancy.

- Incoming Water Flow Rate: 10 cfs (4450 gpm)
- Incoming Water Temperature: 25.0ºC (77.0ºF)
- Outlet (Chilled) Water Temperature: 16.0ºC (60.8ºF)

Although the mean Summer temperature for the incoming water from San Luis Reservoir recorded over the period from 1999-2020 has been measured in the range of 21-22ºC, the 25ºC design incoming water design temperature selected for chiller plant operation is based on a 99% level of peak monthly recordings over the 21-year period.

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Outside of the 99% level of peak monthly recordings, the water from San Luis Reservoir has been measured at temperatures up to 30ºC. When the San Luis Reservoir temperature exceeds 25ºC, the redundant (standby) unit would be called into operation. The 10 cfs design water flow rate would be maintained under this secondary mode of operation. The outlet water temperature achieved under this mode of operation would not exceed 18ºC under any incoming water temperature condition. The outlet temperature with the use of the standby unit would depend on the system arrangement. The larger standby unit (1500-ton, for a 2+1 design) would produce a lower temperature than a smaller standby unit (1100-ton for a 3+1 design).

The chiller plant shall be designed with a by-pass pipeline that would allow water to be diverted to Coyote Creek without passing through the chiller plant. The by-pass pipeline would be a part of the sidestream operation that is independent of the off-season operation of the Coyote Discharge Line.

Chiller Plant Layout

Kennedy Jenks issued an RFI solicitation to area vendors with experience in the manufacture, assembly , and sale of industrial chiller systems. Seven vendors responded to the January RFI solicitation. Table 1, below, provides information of the responses received.

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Table 1 – RFI Response Summary

Vendor	Chiller Mfr/Model	Chiller Arrangement	Chiller Plant Design Footprint (LxWxH)	Cost	Delivery	Options Noted
American Chiller Service	Carrier 19XRV	2+1, 1350-ton	40’x60’	$3,753,000	28-30 weeks	Cooling Tower option (+$973K)
	Smardt VTTX (Turbocor™ design)	3+1, 865-ton	40’x80’	$4,523,000	28-30 weeks	Cooling Tower option (+$769K)
Ascent HVAC	York YMC2	2+1, 1300-ton	48’x63’x12½’	$7,500,000	29 weeks	incl. Buffer Tank; Cooling Tower option (+$480K) Additional information requested, pending
Chillermen (dba Fluid Industrial Manufacturing, Inc.)	Trane CVHF	3+1, 850-ton	(4), 40’x12’x13’	$6,200,000	8-9 months	base bid includes cooling towers, open loop design (no heat exchangers), filter skid Additional information requested, pending
Norman Wright Mechanical	Daikin WSC	2+1, 1300-ton	(3), 44’x15’x14’	$4,225,000	Additional information requested, pending	
Sigler Commercial	Carrier 19XRV	3+1, 867-ton	Additional information requested, pending	$5,815,727	20-24 weeks	
		2+1, 1300-ton	Additional information requested, pending	$5,095,296		

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Vendor	Chiller Mfr/Model	Chiller Arrangement	Chiller Plant Design Footprint (LxWxH)	Cost	Delivery	Options Noted
Stellar Energy	Trane CVHH	3+1, 1000-ton	40’x70’x15’	$4,660,000	8-10 months	Cooling Tower option (+$340K)
Canaaris (Trane)	Trane CVHF	2+1, 1300-ton	37’x71’	$4,500,000	4-6 months	base bid includes cooling towers Additional information requested, pending

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The vendors submitted variations of two chiller plant design concepts:

- Skid-mounted enclosures for each chiller unit with accessory equipment. External piping connections shall be provided with each enclosure. Header piping between units is to be located outdoors, external to the enclosures.

- Skid mounted assemblies for each chiller unit within a common enclosure. Adjoining chiller skids are to be bolted together with open walls between adjoining skids. Header piping between units is to be located within the enclosure.

The chiller plant location selected from the Site Selection Workshop is more than 200 feet from the nearest residential fenceline. The chiller plant is to be designed to set the noise level at the adjoining residential fenceline below the 60 decibel requirement referenced in the City of Morgan Hill Municipal Code.

The chiller site selection process assumed a 130’x75’ footprint for the placement of chiller plant equipment, chiller equipment access, header piping, accessory pumps and strainers, and electric service equipment. The equipment layouts received from the vendor responses show the assumed 130’x75’ area to be conservative for final design.

Chiller Selection

In developing a chiller plant of 2600-ton nominal capacity (10 cfs, 25ºC-in, 17ºC-out), with redundancy, that was noted in the RFI solicitation, the seven vendors that responded produced variations of two standard chiller plants:

- Two 1300-ton capacity chillers with a third unit as standby (referred to as a 2+1 design)

- Three 900-ton capacity chillers with a fourth unit as standby capacity (referred to as a 3+1 design)

Every vendor proposal included the selection of centrifugal chillers. The use of rotary screw chillers or reciprocating chillers are optional chiller designs, but are not typically available at capacities exceeding 900 tons. The selection of rotary screw or reciprocating chillers would require more operating units to achieve the 2600-ton capacity. The use of additional chiller units would increase the footprint of the chiller plant. The interconnection of a greater number of chiller units would also contribute additional cost to system development.

On review of the vendor proposals, Kennedy Jenks recommends the use of the 2+1 design. For those vendors submitting both 2+1 and 3+1 design options, the 2+1 design can be supplied at a lesser cost than the 3+1 design. Further, the greater size of the standby unit allows for a greater overall plant capacity on the rare occasions where operation of the standby unit is needed to address high inlet water temperature conditions from the Santa Clara Conduit.

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The submitted centrifugal chiller packages all incorporate variable speed chiller operation. Variable speed operation increases the part-load efficiency of the chiller. Variable speed operation is a good option for the system design. Variable speed operation allows for better chiller plant operation over the wide range of incoming water temperatures from the Santa Clara Conduit. Variable speed operation also limits sudden ‘temperature shocks’ within the system as individual chiller units are brought online and taken offline. The limiting of these temperature shocks, along with the pass-through (non-recirculating) design of water being diverted to Coyote Creek would eliminate the need for buffer tanks that are provided in some circulating chilled water system designs.

Most of the chiller package submittals included oil-lubricated chillers. However, some submittals identified chiller units using the Turbocor™ shaft design, incorporating a magnetic bearing system, as an additional cost option. The Turbocor™ design allows for the shaft to ‘float’ without bearing contact. The design eliminates the need for shaft lubrication. The elimination of shaft lubrication reduces one ongoing maintenance component; it also eliminates the potential leakage of oil into the water streams passing through the compressor. Although the heat exchanger system described in the ‘Accessory Equipment’ section would eliminate oil leakage as a contamination concern, the Turbocor™ design is recommended nonetheless. The elimination of unit lubrication, and its associated maintenance and inspection practices, along with reduced noise and vibration, gives preference to the oil-less Turbocor™ design.

Heat Rejection Equipment Options

In the refrigeration process used to produce chilled water, the refrigerant absorbs energy from the process fluid and transfers the energy to a heat sink material (e.g. soil, water, or air) through heat rejection equipment.

Chilled water systems in the capacity range of this project typically use one of three types of heat rejection equipment systems described, below. Schematic representations of a chilled water unit incorporating each of the three heat rejection systems are included as Figures 3 through 5.

- Water-cooled Heat Exchangers – The heated refrigerant transfers energy to water within an enclosed heat exchanger that is part of the chiller construction. The heated condenser water from the chiller is circulated through an enclosed piping loop. Another heat exchanger is on the ‘opposite’ side of the piping loop.

  These heat exchanger systems require either a large reservoir or a passing water stream as a heat rejection material. For this application, an additional sidestream from the Cross Valley Pipeline (CVP), the transmission pipeline leaving the Coyote Pumping Plant, would serve as the heat rejection material. The heated condenser water from the chiller would reject heat to the sidestream from the Cross Valley Pipeline. The heated sidestream would be returned to the Cross Valley Pipeline and passed through the CVP to one of the District water treatment facilities. Based on the flow of the sidestream relative to the flow through the CVP, the heat rejected to the sidestream and returned to the CVP would cause an insignificant increase in temperature at the CVP.

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The heat exchangers have the advantage of a small footprint. A review of vendor submittals received from the RFI showed the heat exchangers set within the chiller plant enclosures.

- Air-cooled condensers – In this case, the heated refrigerant transfers energy to a forced air stream located outside of the chiller plant enclosure. The forced air stream absorbs heat from the refrigerant and transmits that energy to the atmosphere.

  The forced air fans are to be located outside of the chiller plant enclosure. Because of the lesser specific heat capacity of air relative to water, the fans incorporated in these systems are much larger than the fans included in cooling tower systems.

  None of the vendors solicited through the RFI process submitted an air-cooled condenser system as a heat rejection option. Individual air-cooled condensers are not readily available at capacities exceeding 500 tons. For condensers of such capacity, the condenser footprint is not practical for rooftop mounting atop the chiller enclosure. Also, the footprint for ground-mounted installations greatly expands the chiller plant footprint. Further, the extended routing of refrigerant piping produces a safety hazard and the associated fans would provide a disturbance in any semi-residential location.

- Cooling Towers – Similar to the water-cooled heat exchanger system described above, the heated refrigerant transfers energy to water within an enclosed heat exchanger that is part of the chiller construction. The heated condenser water from the chiller is discharged to a nozzle system that is open to a forced air stream. The forced air stream absorbs heat and moisture from the nozzle droplets and transmits that energy to the atmosphere. The ‘cooled’ nozzle droplets are collected in a sump and then (re-)pumped through the condenser section of the chiller.

  Cooling towers are located outside of the chiller plant enclosure. A review of vendor submittals received from the RFI showed cooling towers mounted at grade level alongside the chiller plant enclosure, and atop the roof of the chiller plant enclosure.

  Cooling tower systems incorporate circulation pumps to move water between the sump, through the condenser section of the chiller, and to the nozzle system. Cooling towers also incorporate make-up water connections to replace water lost due to evaporation and to replace contaminated water through exposure to the forced air stream, drain connections, and water treatment systems.

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Table 2, below, gives a comparison of capital design and construction considerations for the heat rejection equipment systems, described above.

Table 2 – Capital Design and Construction Concerns for Chiller Heat Rejection Options

Item	Heat Rejection Equipment System		
	Pass-thru Water-cooling	Air-cooling	Cooling Tower
Capital Design and Construction			
Availability	0-1000+ tons	0-500 tons	0-1000+ tons
Additional Space	√ (length)	√ (length[a])	√ (length, height[b])
Additional Cost – Chiller Plant	$20K	More	>$500K
Additional Cost - Piping Infrastructure	$250K	--	$50K[c]
Additional Cost – Instrumentation/Controls	More	Lesser	Most

Notes:

(a) The multiple units required, and spacing, would expand plant footprint beyond 130'x75'
(b) Ground-mounted cooling towers would extend chiller enclosure length ~15 ft. Tower height, 18-20' (Evapco)
(c) Piping Infrastructure costs would also include permitting fees for City of Morgan Hill sewer connection

Table 3, below, gives a comparison of operational considerations for the heat rejection equipment systems, described above.

Table 3 – Operational Considerations for Chiller Heat Rejection Options

Item	Heat Rejection Equipment System		
	Pass-thru Water-cooling	Air-cooling	Cooling Tower
Operations			
Noise	73 db @ 3 ft[a]	>90 db @ 5 ft	>85 db @ 5 ft
Water Consumption	-	-	150-200 gpm
Wastewater Discharge	-	-	20-40 gpm
Moisture (Humidity) Control	-	-	√
Electric Power Consumption[b]	50 hp	400-500 hp	200 hp
Maintenance (Labor, only)			
Periodic (Cleaning, Lubrication, etc.)	~ $1000/yr	~ $5,000/yr	> $10,000/yr
Parts Replacement	Not Likely	Possible	Likely

Notes:

(a) Chiller unit enclosure provided with sound attenuation to limit noise to 73 db
(b) Estimated power consumption for 4000 ton chiller plant

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The pass-through, water-cooled heat rejection design is recommended for operation with the proposed large-capacity chiller plant. The Cross Valley Pipeline is available as a heat rejection reservoir and is in reasonably close proximity. The capital cost of the added piping infrastructure for the water-cooled system is projected to be less than the added chiller plant costs of either the cooling tower or air-cooled condenser options. The water-cooled system has far fewer operational impacts, including low noise, lesser power consumption, lesser maintenance, no additional sewer or water infrastructure from the City of Morgan Hill.

Alternate Design – Two-Stage Cooling

An alternative design that was generated during the internal quality review process is a two-stage cooling process (Figure 6), incorporating the use of cooling towers in combination with refrigerant-based chillers for cooling of the water to be diverted to Coyote Creek. (NOTE – This is distinct from the use of cooling towers as a heat rejection system mentioned in the previous section.)

The use of cooling towers for direct cooling of the diverted water is based on the San Francisco Bay region's dry Summer climate with low humidity, where wet-bulb temperatures do not exceed 70ºF. An interface of warm water with a high-flow air stream can reduce the water temperature to the air's wet-bulb temperature. The cooling tower design provides this interface. The cooling tower process would reduce the incoming water temperature down to ~70ºF under the warmest incoming water conditions. The water cooled from the cooling towers is then routed to a 'reduced-capacity' version of the refrigerant chiller plant described previously.

To the extent that the cooling tower process can be used to lower water temperature, the process uses a small portion (~30-40%) of the electrical power that would be used to cool an equivalent water quantity through a refrigerant chiller.

As cooling towers are open to atmosphere, a series of pumps would be required to move water from the cooling towers through the heat exchangers included in the second-stage refrigerated chiller system and to the outlet at Coyote Creek.

The use of cooling towers upstream of the refrigerant chillers would reduce chiller plant capacity to a total of 1700-1800 tons, or 40-45% of the capacity described earlier in this section. The overall electrical demand for the two-stage process would be approximately one-half that of a system using refrigerant-based chillers only.

The use of cooling towers in the two-stage process could introduce contaminants to the water being diverted to the creek. This would include particulates such as wildfire ash or agricultural dust, or biological contaminants such as insects and bird waste from birds perching on the rims of the cooling towers. The use of cooling towers would also result in water loss to evaporation.

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Accessory Systems

In addition to the chiller unit and heat rejection systems, the chilled water plant would incorporate the accessory features described in the section, below.

Protection of Chilled Water and Heat Rejection Piping from Contamination

Both the process fluid (chilled water) in this application and the heat rejection fluid, if used, are untreated water. The eventual destination of the process fluid is Coyote Creek. The eventual destination of the heat rejection fluid is the Cross Valley Pipeline and on to the District's water treatment facilities. A schematic of the chilled water system piping on the CPP site is included on Figure 7.

In an effort to isolate the chiller equipment from potential contaminants in the process fluid, the design calls for the incorporation of 'protected' heat exchangers into the chiller plant design.

The evaporator fluid passing through the chiller would be a recirculating loop with a dedicated circulation pump. The chiller would cool the evaporator fluid and the heat exchanger would transfer heat to the evaporator fluid while removing energy from the process fluid, producing chilled water.

If the water-cooled heat rejection system is selected, the condenser fluid passing through the chiller would be of a similar design, incorporating a recirculating loop with a dedicated circulation pump. The chiller would heat the condenser fluid and the heat exchanger would reject heat from the condenser fluid to the heat rejection fluid.

Automatic Strainer Systems

The addition of automatic strainer units to the sidestream supplying water to the chiller plant has been discussed previously with Valley Water personnel as a means of controlling invasive materials from the transmission system from being introduced to Coyote Creek. The discussions took place without an understanding of the current operation of the Coyote Discharge Line which does not include a filter or strainer system. For the single-stage chiller plant designs incorporating refrigerant-based chillers, only, the planned chilled water system operation would not introduce foreign materials to the sidestream. Without additional rationale from Valley Water to justify their installation, Kennedy Jenks does <u>not</u> recommend the addition of automatic of manually-operated strainers for this chiller plant design.

For the two-stage process where water being diverted to Coyote Creek passes through cooling towers, contaminants could be introduced to the process. As mentioned previously, the potential contaminants include particulate matter such as wildfire ash or dust from agricultural operations, as well as biological contaminants such as bird droppings or insects. Further assessment would be required to determine whether water quality would be affected to the extent of being harmful to the creek habitat. For this, the use of screens or filters may be warranted. The energy to pass

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water through the filters would be delivered from the pump system at the outlet of the cooling tower manifold.

Booster Pump Systems

The sidestream supplying water to the chiller plant would be drawn from the Cross Valley Pipeline (CVP). The pressure of the water in the CVP would be adequate to pass through the evaporator-side heat exchanger within the chiller unit and discharge water to the existing outlet at the end of the Coyote Discharge Line without additional pumping.

If the water-cooled heat rejection system is selected, the pressure drop through the sidestream piping and the condenser-side heat exchanger within the chiller unit would have to be restored through a booster pump system to provide adequate pressure for the sidestream to be returned to the Cross Valley Pipeline.

For the two-stage cooling process, an additional set of booster pumps would be required to move water from the outlet of the first-stage process through the heat exchangers included in the second-stage refrigerated chiller system and onward to the outlet at Coyote Creek.

Chiller Plant Enclosures

For the chiller plant layouts described earlier, the chiller unit enclosures are to be designed to limit sound output to 73 decibels at a distance of 1 meter (3 feet) outside of the enclosure.

If equipment is installed outside of the chiller unit enclosures (e.g. cooling towers), additional sound attenuation barriers would be provided to limit the sound output to meet the 60 decibel requirement at adjoining residential fencelines referenced in the City of Morgan Hill Municipal Code.

Chiller Plant Electric Power Distribution System

The chiller plant would draw power from the WAPA switchyard, located on the Coyote Pumping Plant property. A 4160-volt line from the switchyard would be routed to a new transformer in the chiller plant location to distribute 460-volt, 3-phase to the chiller system.

Each chiller enclosure would contain a single-point power supply connection, 460-volt, 3-phase Motor Control Center/Power Distribution Panel. The panel would distribute power to the chillers, circulation pumps, motorized valves associated with the chilled water plant equipment, and for accessory equipment outside of the chiller plant enclosures, where required (e.g. booster pumps, strainers). The panel would also supply power to accessory lighting, receptacles, HVAC equipment, and instrumentation/controls within the enclosure.

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Chiller Plant Automation System

Each chiller unit would contain its own control module consisting of a programmable logic control (PLC) module, incorporating Modbus or BACNet protocols, a wireless communication module, and an Operator Interface Panel with LCD screen for local monitoring and control of chiller and its associated equipment.

The overall chiller plant would incorporate an additional control module containing a separate PLC and wireless communication module. The additional module would provide for operation, monitoring and control of automated equipment (valves, pumps, strainers) and electronic field instrumentation (pressure transmitters, flow transmitters) supplied by others, outside of the chiller units.

Equipment Workshop and Conclusion – System Recommendation

Kennedy Jenks initially recommended the design of a two-stage water-cooling in the draft technical memorandum primarily based on the reduction of capital and operating costs. During the equipment workshop, Valley Water staff raised concerns about higher noise levels and equipment maintenance involved with the use of cooling towers. Table 4 summarizes the evaluation criteria, weighting factors, ratings and scores for each of the four alternatives.

Table 4 – Coyote Creek Chiller Evaluation Workshop Alternatives Evaluation Results

Coyote Creek Chiller Project Equipment Evaluation Criteria Matrix			Alt 1 - Water Cooled Heat Exchanger		Alt 2 - Air Cooled Condensers		Alt 3 - Cooling Tower		Alt 4 - Cooling Tower/Water Cooled Heat Exchanger	
	Evaluation Criteria	Weighting Factor(1)	Rating(2)	Weighted Score	Rating(2)	Weighted Score	Rating(2)	Weighted Score	Rating(2)	Weighted Score
		(A)	(B)	(A x B)	(B)	(A x B)	(B)	(A x B)	(B)	(A x B)
1	Equipment Cost	9	3	27.0	1	9.0	2	18.0	5	45.0
2	Operating Costs - Elec Power	10	3	30.0	1	10.0	2	20.0	5	50.0
3	Ambient Noise	8	5	40.0	2	16.0	2	16.0	2	16.0
4	Visibility Factor	7	4	28.0	3	21.0	3	21.0	3	21.0
5	Operations and Maintenance Effort	6	4	24.0	4	24.0	3	18.0	1	6.0
6	Impact from Poor Air Quality	5	5	25.0	5	25.0	4	20.0	4	20.0
7	Warm Temp Water to CVP	2	3	6.0	5	10.0	5	10.0	4	8.0
8	Sewer Hookup	8	5	40.0	5	40.0	3	24.0	5	40.0
9	Water Consumption	1	5	5.0	5	5.0	4	4.0	4	4.0
10	Equipment Footprint	3	4	12.0	2	6.0	3	9.0	3	9.0
11	Control Complexity	4	4	16.0	5	20.0	3	12.0	2	8.0
	Total Score for Each Alternative(3):			253.0		186.0		172.0		227.0

Notes:

(1) Weighting Factors are between 1 and 10 with 10 being the most important and 1 being the least important.

(2) Ratings for each Evaluation Criterion are between 1 and 5 with 5 being the most favorable and 1 being the least favorable. Values shown are automatically copied from Evaluation Summary tab.

(3) Alternatives with higher Total Scores represent more favorable alternatives.

One of the notable advantages of the water-cooled heat exchangers as heat rejection equipment is that all chiller plant equipment is located within enclosures. The design parameters call for enclosures to be designed to limit sound to 73 decibels at a distance of 1 meter (3 feet) outside of the enclosure. With a distance of more than 200 feet from the chiller plant to the

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nearest residential fenceline, the sound intensity reduction over distance is expected to set the noise level at the residential fenceline at 45 decibels, well below the 60 decibel requirement referenced in the City of Morgan Hill Municipal Code. The sidestream design supplying water to the chiller plant would incorporate a by-pass line, allowing water to be diverted to Coyote Creek without cooling, independent of the off-season operation of the Coyote Discharge Line.

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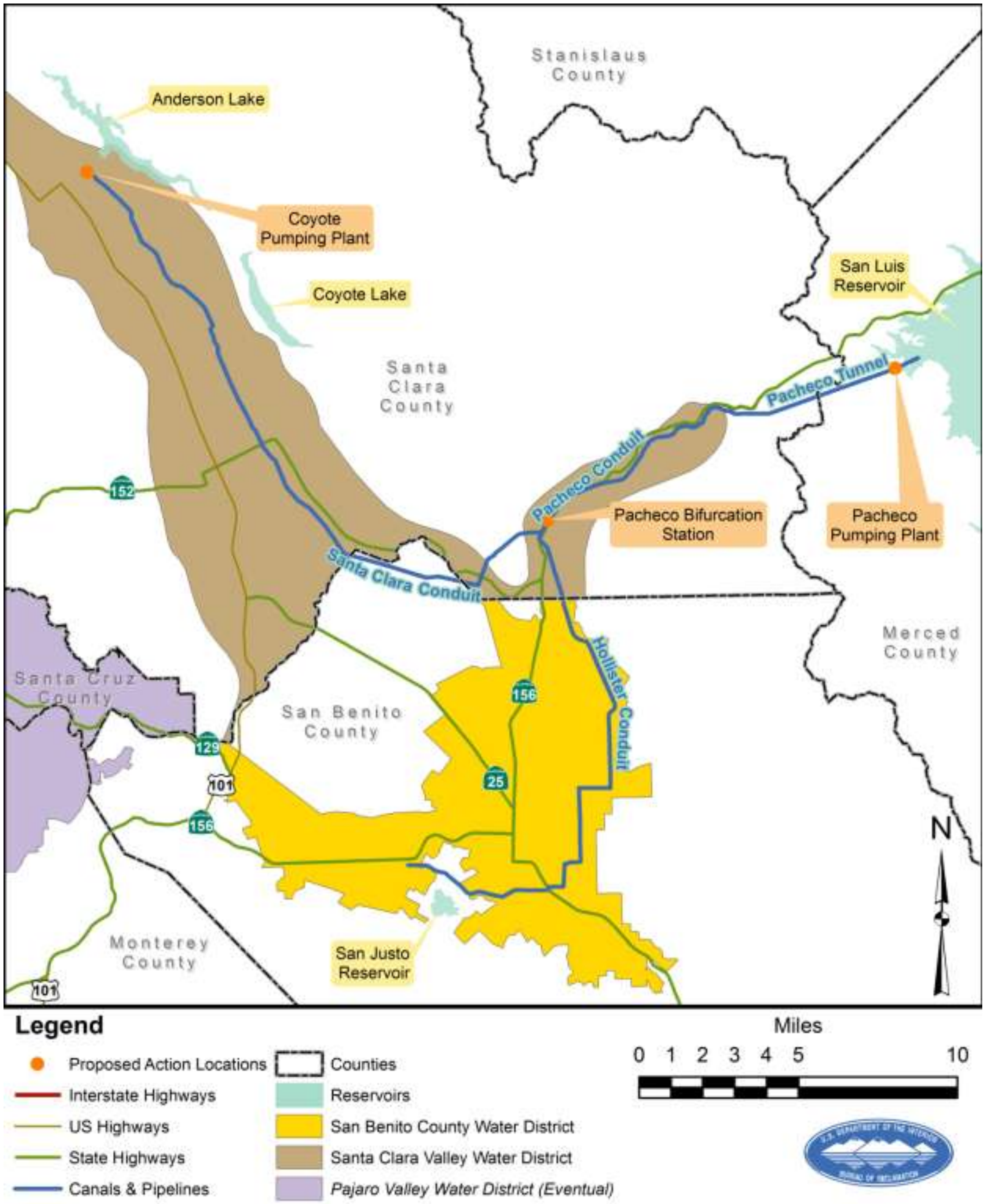
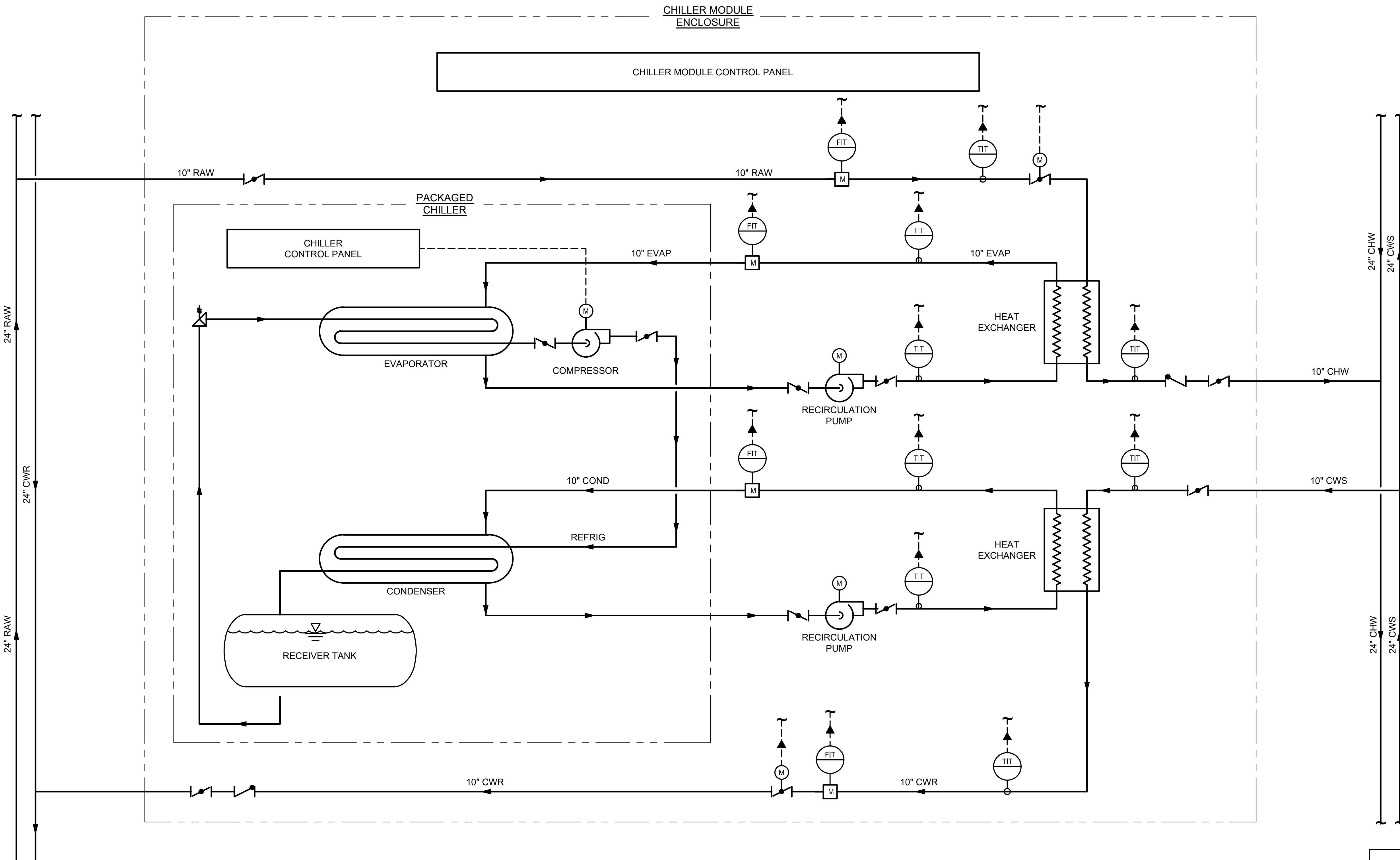


Figure 1 - Pacheco-Santa Clara Conduit Transmission System

Google Maps

Figure 2 - Coyote Pumping Plant Site Layout (2018) 100 ft



LEGEND:

CHW - CHILLED WATER (TO CREEK)
COND - CONDENSING WATER LOOP
CWS - COOLING WATER SUPPLY
CWR - COOLING WATER RETURN
EVAP - EVAPORATIVE SOLUTION LOOP
FIT - FLOW TRANSMITTER
RAW - RAW WATER
REFRIG - REFRIGERANT LOOP
TIT - TEMPERATURE TRANSMITTER

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VALLEY WATER COYOTE CREEK
CHILLED WATER DISCHARGE

CHILLED WATER MODULE
WATER COOLING OPTION

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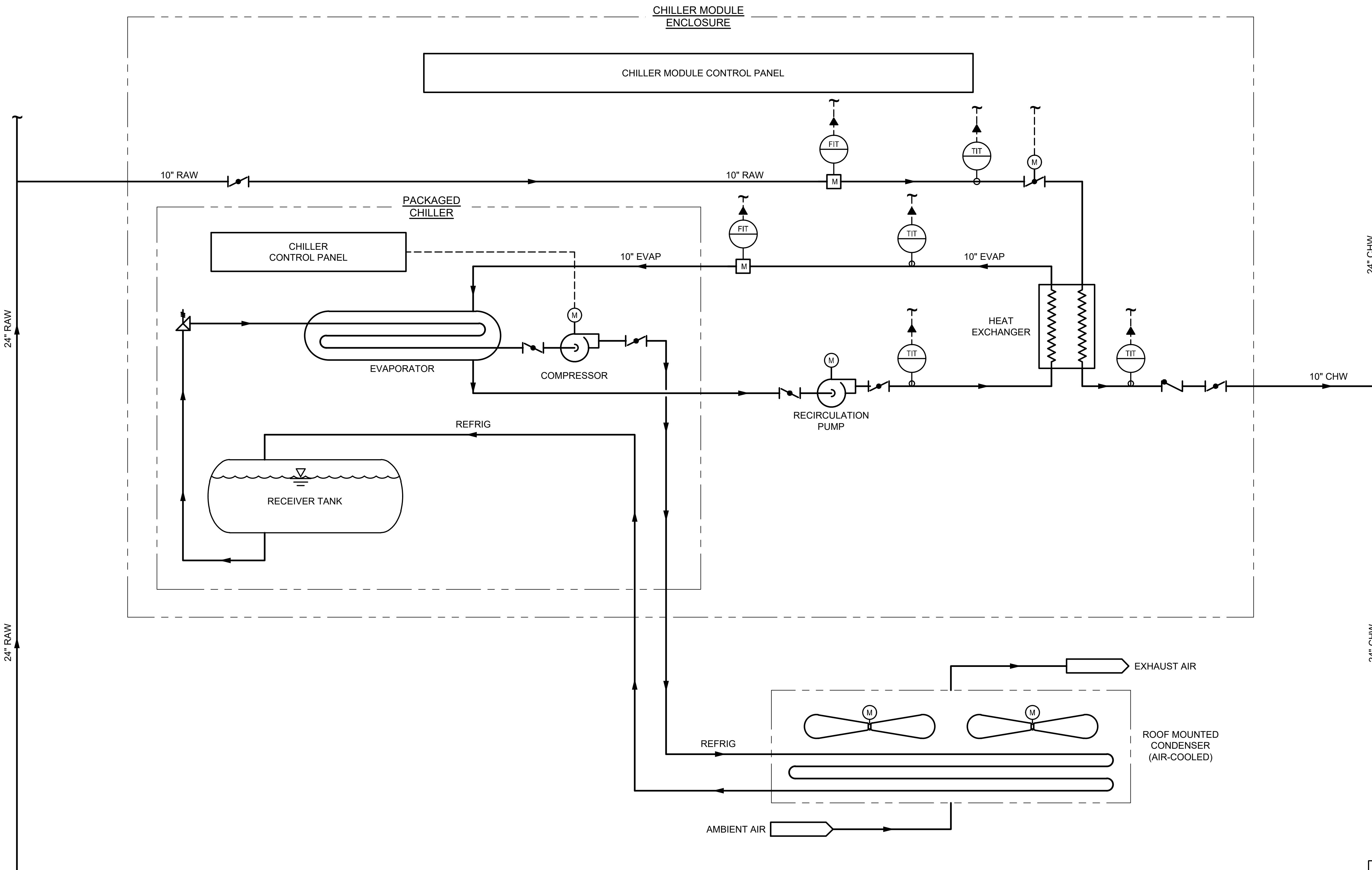
FIGURE 3



LEGEND:

CHW - CHILLED WATER (TO CREEK)
COND - CONDENSING WATER LOOP
CWS - COOLING WATER SUPPLY
CWR - COOLING WATER RETURN
EVAP - EVAPORATIVE SOLUTION LOOP
FIT - FLOW TRANSMITTER
RAW - RAW WATER
REFRIG - REFRIGERANT LOOP
TIT - TEMPERATURE TRANSMITTER

N:\2017\1768020.06 - SCValley Water Coyote Creek\1768020-FIG 3.dwg NAP BRAVO 1/13/2021 12:17 AM

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VALLEY WATER COYOTE CREEK
CHILLED WATER DISCHARGE

CHILLED WATER MODULE
AIR-COOLED CONDENSER OPTION

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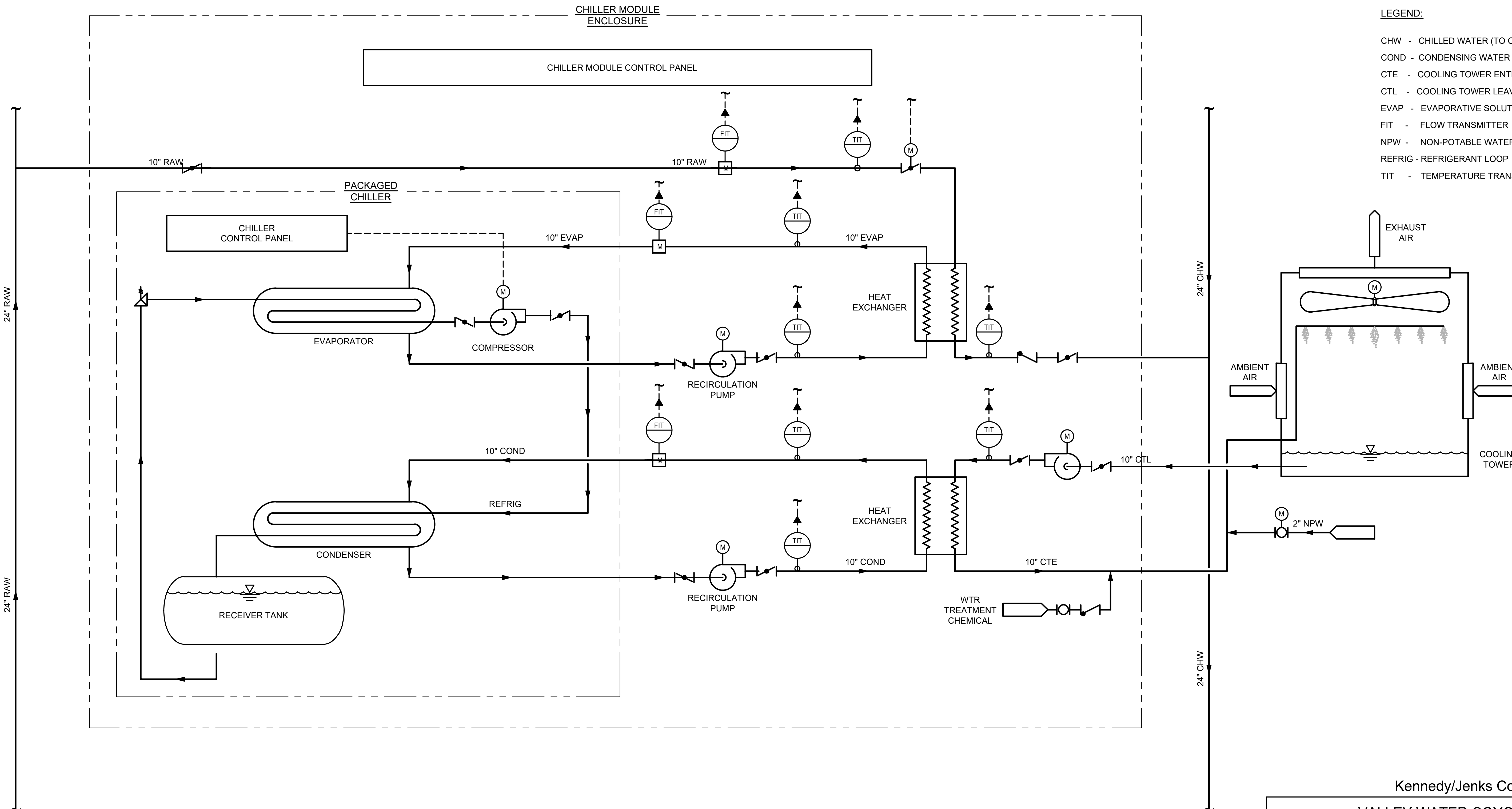
FIGURE 4



LEGEND:

CHW - CHILLED WATER (TO CREEK)
COND - CONDENSING WATER LOOP
CTE - COOLING TOWER ENTERING
CTL - COOLING TOWER LEAVING
EVAP - EVAPORATIVE SOLUTION LOOP
FIT - FLOW TRANSMITTER
NPW - NON-POTABLE WATER
REFRIG - REFRIGERANT LOOP
TIT - TEMPERATURE TRANSMITTER

N:\2017\1768020.06 - SCValley Water Coyote Creek\1768020-FIG 4.dwg ZACHARY HARRIS 1/13/2021 9:11 AM

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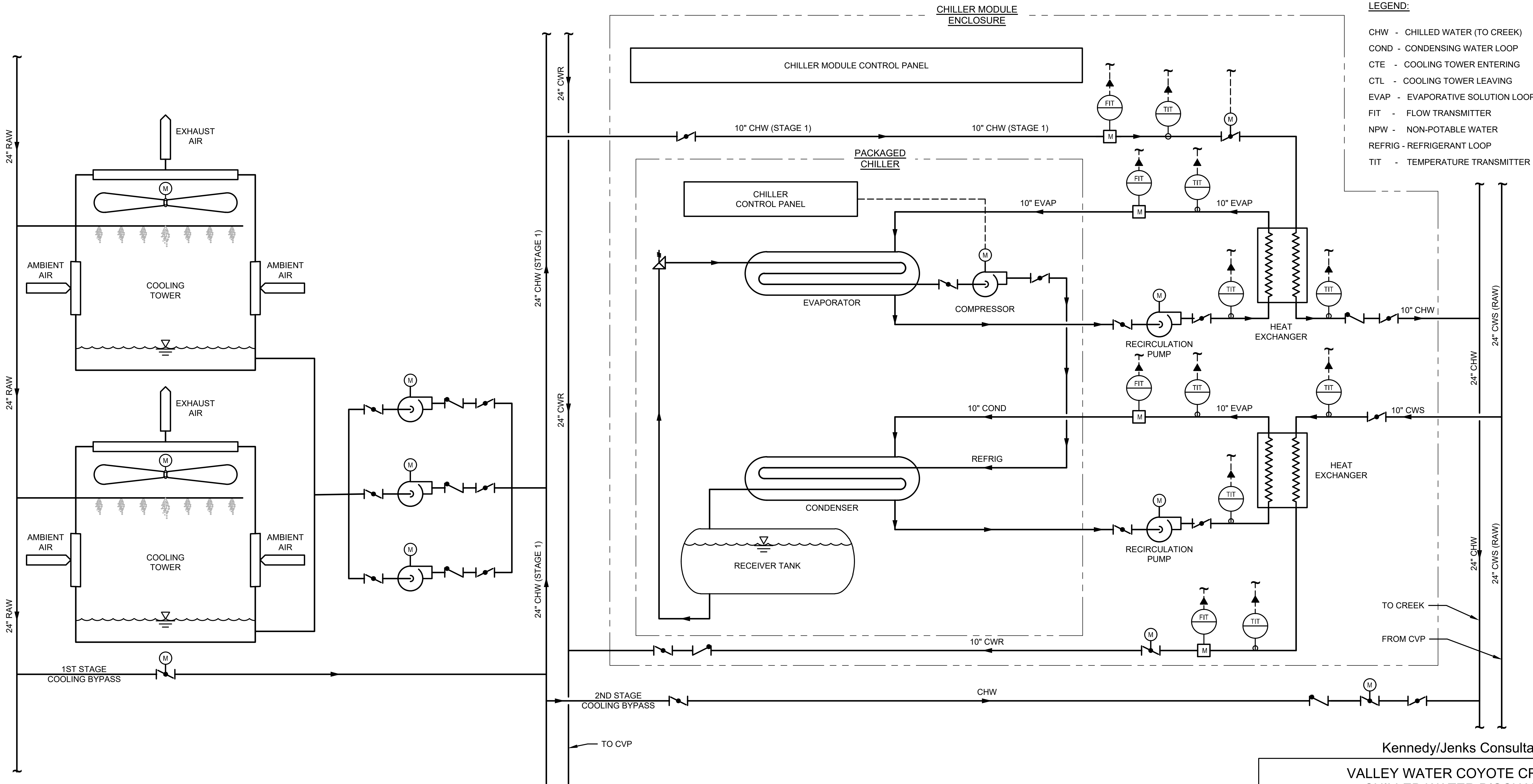
VALLEY WATER COYOTE CREEK
CHILLED WATER DISCHARGE

CHILLED WATER MODULE
COOLING TOWER OPTION

KJ 1768020.06

FIGURE 5



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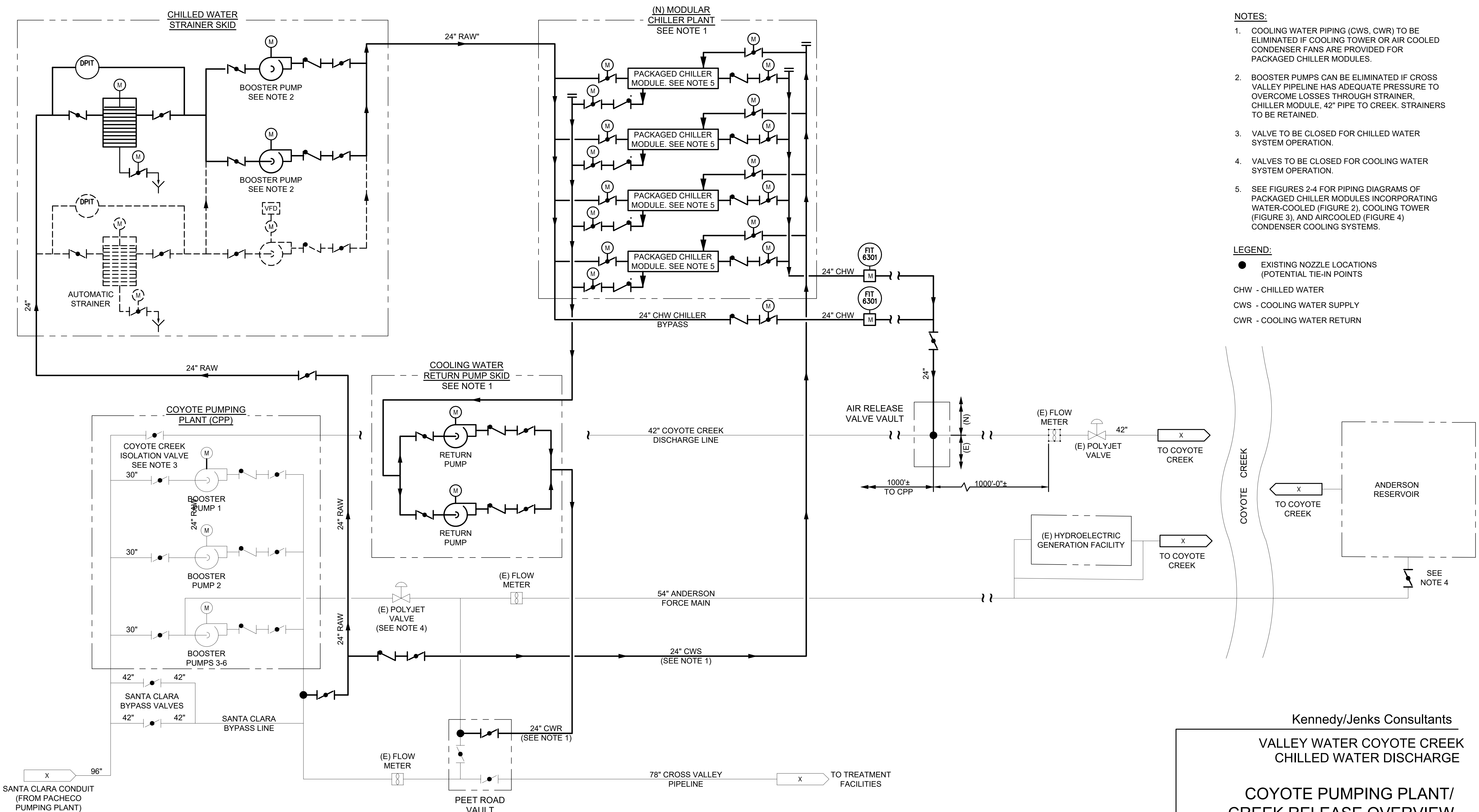
VALLEY WATER COYOTE CREEK
CHILLED WATER DISCHARGE

CHILLED WATER MODULE
TWO-STAGE COOLING OPTION

KJ 1768020.06

Figure 6

N:\2017\1768020.06 - SCValley Water Coyote Creek\1768020-FIG 5.dwg NAP BRAVO 2/5/2021 1:10 PM



NOTES:

1. COOLING WATER PIPING (CWS, CWR) TO BE ELIMINATED IF COOLING TOWER OR AIR COOLED CONDENSER FANS ARE PROVIDED FOR PACKAGED CHILLER MODULES.
2. BOOSTER PUMPS CAN BE ELIMINATED IF CROSS VALLEY PIPELINE HAS ADEQUATE PRESSURE TO OVERCOME LOSSES THROUGH STRAINER, CHILLER MODULE, 42" PIPE TO CREEK. STRAINERS TO BE RETAINED.
3. VALVE TO BE CLOSED FOR CHILLED WATER SYSTEM OPERATION.
4. VALVES TO BE CLOSED FOR COOLING WATER SYSTEM OPERATION.
5. SEE FIGURES 2-4 FOR PIPING DIAGRAMS OF PACKAGED CHILLER MODULES INCORPORATING WATER-COOLED (FIGURE 2), COOLING TOWER (FIGURE 3), AND AIRCOOLED (FIGURE 4) CONDENSER COOLING SYSTEMS.

LEGEND:

● EXISTING NOZZLE LOCATIONS (POTENTIAL TIE-IN POINTS

CHW - CHILLED WATER

CWS - COOLING WATER SUPPLY

CWR - COOLING WATER RETURN

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VALLEY WATER COYOTE CREEK
CHILLED WATER DISCHARGE

COYOTE PUMPING PLANT/
CREEK RELEASE OVERVIEW

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Figure 7

N:\2017\1768020.06 - SCValley Water Coyote Creek\1768020-FIG 1.dwg NAP BRAVO 1/13/2021 12:28 AM